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Effect of different host plants of normal wheat aphid (*Sitobion avenae*) on the feeding and longevity of green lacewing (*Chrysoperla carnea*)

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Abstract. The role of two different hosts of normal wheat aphid (*Sitobion avenae*) on feeding and longevity of larvae of green lacewing (*Chrysoperla carnea*), were conducted in laboratory conditions (50 ± 1 ˚C 70 ± 5 % RH and photoperiod of L16: D8). In this study wheat aphid had fed on wheat (main host) and oleander (compulsory host) for twenty days. For the experiments we used 3rd and 4th instars of aphids and 2nd instar larvae of green lacewing. The results were compared by each other and oleander aphid (*Aphis nerii*). Significant effects of host plant and aphid species on feeding rate and longevity of green lacewing were observed. The average feeding rate of 2nd instar larvae of *C. carnea* on wheat aphid fed on wheat, oleander aphid and wheat aphid fed on oleander were 40.3, 19.5, 30.6 aphids respectively. Also the longevity of 2nd instar larvae of green lacewing which fed on different aphids was recorded as 3.7, 7.8 and 6 days respectively. The results showed that biological characteristics of larvae of *C. carnea* are influenced by the quality of food which they fed on.

Keywords: host plant effect, Biological control, *Chrysoperla carnea*, *Sitobion avenae, Aphis nerri*

1. Introduction

Chrysopidae lacewings family has been amongst useful insects of agricultural ecosystems which is very effective and practical in biological control programs against agricultural pests (Canard *et al.*, 1984). This family included more than 90 types and 1800 well- known species which their predating behavior always attracted the entomologists' intention in biological control programs (Brook & Barnard, 1990). So far, it has been reported 193 lacewings species in Iran of which 46 species are members of Chrysopidae family (Farahi *et al.*, 2009). The green lacewing *Chrysoperla carnea* Stephens is amongst the predators of aphids, mealybugs and some other pests which feed them at different ages of larvae, led to decrease the pest population. The main factors may affect the feeding and function of a predator as a biological control agent are edacity, functional response, numerical response, host preference and ability of a predator to hunt its prey and environmental conditions (Messina &Sorenon, 2000). The present study is aimed to determine the feeding of *C. carnea* from normal wheat aphid (*Sitobion avenae*) which fed from oleander extract after forming a colony for 20 days; and compare the feeding of this lacewing from normal wheat aphid (*S. avenae*) fed on normal host (wheat) and oleander aphid (*Aphis nerri*). Also it is tried to measure longevity of 2nd instar larvae of *C. carnea* which fed on different aphids. Those host plants on which the aphids feed may decrease or increase the quality of aphid foods for their predators and it is, in return, affect the development, survival and predation abilities of *C. carnea* lacewing. Some aphid species have compounds in their bodies may be poisonous for their natural enemies, for example, glycoside cardiac which inhabits in oleander aphid (*A. nerri*) and has high toxicity for *C. carnea* (Liu & Chen, 2001). The aim for establishing the colony of *A. nerri* aphid on oleander was to understand whether *S. avanae* aphid feed on oleander extract would make the

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aphid undesirable for lacewing or if the aphid move from wheat to oleander or plants alike due to exceeding spraying and feed on them and then return once the poison occurrence period is over on wheat, the lacewing effect on aphid control would be the same as the initial rate, that is, before aphid feeding on oleander.

2. Materials and methods

Since it is necessary to have a high concentration of aphids to be used in different experiments, the wheat was planted to collect *S. avenae* species and also *A. nerri* were collected over the available oleander trees in the campus of Ferdowsi University of Mashhad. After planting wheat and its contamination by a colony of *S. avenae* aphid (the dominant species in Mashhad), the contaminated parts of any shrub was cut, on daily basis, by scissor, put in a container and moved to the laboratory. Besides, a small oleander needling was placed in the greenhouse area and sprayed three times by Primor® and Metasistox® poisons completely. Then it was cleared free of any aphid, especially oleander aphid. We placed about 250 *S. avenae* aphids on a sterilized oleander needling and after 14 days a colony of *S. avenae* appeared on oleander. The third instar larvae of lacewing are very edacious but the 1st instar larvae of oleander are weak and have a high mortality rate (El-Wakeil, 2003). In this research, we used the 2nd instar larvae of lacewing, readily provided by Khorasan Razavi Natural Resource and Agricultural Research Center in Mashhad, during the testing period on daily basis. To determine *C. carnea* feeding on normal wheat aphid (*S. avenae*) which fed on two different hosts including wheat and oleander and comparing this lacewing on normal wheat aphid (*S. avenae*) and oleander aphid (*A. nerri*), we select 10 glass petri dishes (9 cm diameter and 1.5 cm height) for any testing stage. At the beginning a wet filter paper placed at the bottom of every petri dish. In this experiment, we used 3rdand 4thinstars of aphidsand mature aphids were removed due to parthenogenesis. At least 60 aphid nymphs counted and placed in the petri dish. A one-day-old 2nd instar larva of lacewing put in every petri dish. Then the petri dishes placed in the incubator under 25±1°C temperature, 70±5 % relative humidity and 17 hours of lighting period. The petri dishes were brought out of incubator every 24 hours and the remaining nymphs on leaves, number of fed aphids were recorded. Another experiment was achieved on feeding and breeding of 2nd instar larvae of green lacewing on normal wheat aphid (*S. avenae*), the *S. avenae* aphid fed on oleander shrub, and oleander aphid (*A. nerri*) and measuring the longevity of 2nd instar larvae. So, aone-day-old 2nd instar larva of lacewing put in every petri dish and fed by 60 aphids for its initial feeding. The petri dishes were placed in incubator under laboratory conditions. The petri dishes were brought out of incubator every 24 hours and fed by another 60 aphids. This process recurred until the 2nd instar larvae shed and turned to a 3rd instar larvaeand ultimately the longevity of 2nd instar larva (from appearance til shedding to 3rd instar) counted and recorded. Analysis of variance (ANOVA) (PROC GLM, SAS Institute, 2003) was used to analyze the effect of different hosts on feeding and longevity of 2nd instar larva of green lacewing. If significance differences were detected, multiple comparisons were made using the Duncan procedure (α = 0.05).

3. Results and discussion

The biology and behavior of *C. carnea* larvae is highly depended on the quality of food which they fed on (Canard *et al.*, 1984). The results showed that these larvae indicate different behaviors when they feed on different hosts and the longevity of 2nd instar larvae varies with the quality of food. Table 1 shows the results. The results showed that the average feeding rate of 2nd instar larvae of *C. carnea* on *S. avenae* and *A. nerri* aphids and the *S. avenae* which fed on oleander tree for 20 days after forming a colony on oleander shrub were respectively, 40.3, 19.5 and 30.6 aphids.

As it is seen from the Figure 1, there is a significant difference between the feeding of 2nd instar larvae of lacewing on the aphid. The highest feeding rate of thelacewing belonged to their feeding on *S. avenae* and *A. nerri* had the lowest feeding rate. The personal examinations also showed that the feeding of lacewing larva on *A. nerri* had caused the sickle-like jaws of larva stick by the adhesive yellow materials of aphid body and prevents feeding of larva at the next phases, in some cases, those larvae with weak jaws and less compatibility were destroyed and we had to repeat the test.

Table 1 – Number of aphids fed by 2nd instar larvae of green lacewing (*Chrysoperla carnea*).

Replication / Aphid	1	2	3	4	5	6	7	8	9	10	Average of aphids fed by green lacewing
Sitobion avenae	38	46	39	40	42	45	42	43	36	42	41.3 ± 3.09 a
Aphis nerii	22	19	20	18	20	21	18	19	21	17	19.5 ± 1.58 c
S. avenae fed on oleander	30	32	28	35	29	26	29	27	34	36	30.6 ± 3.47 b

* Within last column, mean values followed by different letters are significantly different (P<0.05).

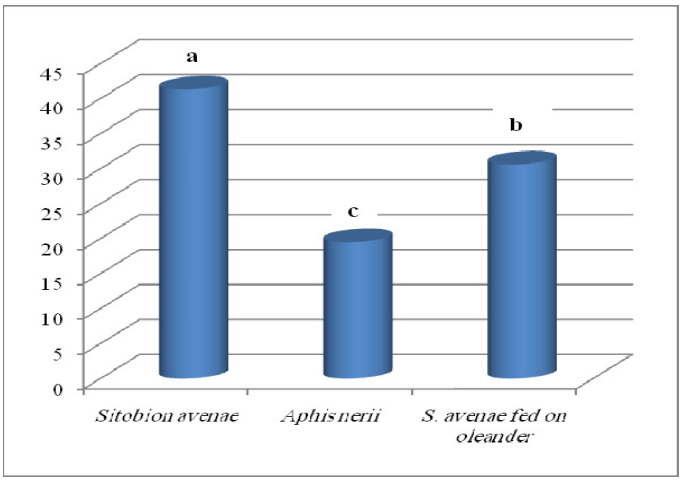

Fig. 1- The feeding of 2nd instar larvae of green lacewing (*Chrysoperla carnea*) on different aphid hosts. Differing letters indicate a significant difference (*P* <0.05)

The quality of food of lacewing larva may affect increase or decrease in its different instars (Canard, 2001). The results also showed that due to the feeding of 2nd instar larvaeof lacewing on normal wheat aphid (*S. avenae*), oleander aphid (*A. nerri*) and the normal wheat aphid forced to feed for a short time on oleander shrub, the longevity of 2nd instar larvaevaries which the results are as follow.

Table 2 – The longevity of 2nd instar larvae of green lacewing (*Chrysoperla carnea*) fed on different aphid hosts.

Replication / Aphid	1	2	3	4	5	6	7	8	9	10	average longevity of 2nd instar larvae of *C. carnea*
Sitobion avenae	3	4	4	3	4	4	3	4	4	4	3.7 ± 0.48 c
Aphis nerii	6	8	8	9	7	8	7	8	8	9	7.8 ± 0.91 a
S. avenae fed on oleander	6	5	6	6	7	6	5	6	6	7	6 ± 0.66 b

* Within last column, mean values followed by different letters are significantly different (P<0.05)

The results showed that the average longevity of 2nd instar larvae of *C. carnea* fed on *S. avenae*, *A. nerri* and *S. avenae* aphids inhabited on oleander for 20 days, in this experiment took place 3.7, 7.8 and 6 days, respectively.

The longest time in terms of days for the 2nd instar larvae of lacewing to turn to a 3rd instar larvae of lacewing, belongs to the feeding on *A. nerii* and the shortest time belongs to the feeding on *S. avenae*. The feeding of 2nd instar larvae of lacewing on *S. avenae* fed on oleander, led to the increase in the longevity of 2nd instar larvae in average about 6 days. Thus, not only type of aphid and materials in its body affected the longevity of development period but the feeding on one aphid bred on different plant hosts may decrease or increase in the longevity of larva due to changes in the internal compounds of aphid body. Another reports also exists on the effect of host plant on third trophic level. Legaspi *et al.* (1994) who measured the effect of plant hosts on body weight, development period and survival of *C. rufilabris* lacewing also proved that the lacewing fed on silverleaf whitefly (*Bemisia argentifolii*) bred on cucumber host (*Cucumis sativa* L) and melon (*C. melo* L.), had the quickest development, much longevity and heavier weight rather than the lacewing fed on the same whitefly bred on poinsettia (*Euphorbia phulcherrmi*Willd) and bean (*Phasellus limensis* L). In several *Chrysoperla* species (including *C. carnea*), a high nutritional quality of aphid prey has been shown to result in increased larval development, larval survival, pupal weight, adult longevity, and reproduction rates (Liu & Chen, 2001). Francis *et al.* (2001) reported that when the two spotted lady beetle, *Adalia bipunctata,* fed on *Myzus persicae* bred on white mustard (with high Glucosinolates), lady beetle fitness significantly reduced. The influence of two crucifer plants of *M. persicae* and *Brevicoryne brassicae* on development and reproduction of the hoverfly *Episyrphus balteatus* was measured by Vanhaelen *et al.* (2002). They showed that the predator's rates of development and survival decreased when the predator fed on the aphid reared on the host plant with high glucosinolates. Also larval predators that fed on *B. brassicae* reared on white mustard had higher mortality rates than those with other diets (Vanhaelen *et al.*, 2002). When *M. persicae* or *B. brassicae* reared on oilseed rape were used to feed *A. bipunctata*¸ the larval development duration and pupal duration of the lady beetle were significantly higher for *B. brassicae* (Francis *et al.,* 2000). It suggested that *B. brassicae* was generally avoided by *A. bipunctata* and is also slightly less suitable. Also for *C. carnea* , development was slower and adults were smaller when fed on *B. brassicae* and *M. persicae* reared on two white cabbage cultivars (Rivera and Lennox) (Kos *et al.,* 2011). In addition, two predator species *C. carnea* and *E. balteatus* exhibited slower development when fed the specialist herbivore *B. brassicae*, than when fed the generalist herbivore *M. persicae* (Kos *et al.,* 2011). These suggested that performance of *C. carnea* and *E. balteatus* when fed aphids reared on different cultivars reflected the performance of the aphids themselves on these cultivars. Our study shows that the average feeding rate of 2nd instar lacewing on *S. avenae* aphids inhabited and fed on oleander shrub after 20 days of forming a colony is 30.6 which numerically ranged between the average feeding rate of larva of lacewing on *S. avenae* and *A. nerrii* aphids. Maybe it is because the aphid had short time to feed on oleander extracts and probably with increase in feeding time, the lacewing may not be able to control the aphid. So, it is clear that exceeding sprayings not only may kill the natural enemies such as lacewings but moving the aphids from the main hosts to other non-sprayed plants. If these plants such as oleander have poisonous materials, they may last for a long time in the aphid's body and decrease in the performance of natural enemy against the pest. Supporting the useful lacewings, especially *C. carnea* species, in the fields, gardens and vegetables requires, in the first place, informing the farmers and gardeners of performance of these insects and their life and behavioral characteristics. Since the aphids, mealybugs and other preys are necessary for feeding these useful insects, when the population of the natural enemy is appropriate, we may call off the spraying or decrease its number of occurrence.

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